INTRODUCTION:

Femoroacetabular impingement (FAI) is described as an abnormal impingement caused by bony deformities, between the proximal femur and acetabular rim during hip movement. It is thought to play a role in the development of hip osteoarthritis [1]. Surgical intervention for FAI consists of soft tissue and bony repair in order to restore normal hip range of motion (ROM). The current method for treating impingement in FAI involves iterative debridement and confirmation of the restored ROM. Over resection is likely to occur because the resection outcome can only be assessed after the debridement [2]. To solve this problem, a noninvasive technique to assess hip ROM for FAI has been developed. The aim of this study is to reliably predict the resulting functional ROM achieved for a given pre-operative resection plan in FAI.

METHODS:

Only cam lesions, which are characterized by bony deformities on the femoral head-neck junction [1], have been considered in this study. Stereolithographic bone models of both pathologic and normal proximal left femora as well as a normal acetabulum were generated based on CT images.

Impingement Detection Computer Algorithm and Verification

The speed of the algorithm was maximized through the inclusion of simultaneous broad and narrow phases. Two bottom-up bounding sphere hierarchies of pelvis and femur models were constructed (Fig 1A). In the broad phase, the algorithm started from the highest level (“root”) of both hierarchies and searched for an intersection between any two bounding spheres from different hierarchies, where impingement may be located. If an intersection was detected, the algorithm descended to a lower level and searched for the next intersection. The broad phase search followed a depth-first hierarchy traversal rule and stopped once two hierarchies reached the lowest level (“leaf”). In the narrow phase, the signed closest distance from the vertices within a pelvis leaf bounding sphere to the triangle enclosed by a femur leaf bounding sphere was calculated utilizing Voronoi region and vector analysis. If the closest distance was smaller than a predefined threshold (0.1mm), it was identified as the penetration depth and the impingement was located at the point of the corresponding pelvic vertex and projected femoral point.

To verify impingement detection accuracy, a phantom consisting of a soft tissue and bony repair in order to restore normal hip range of motion (ROM). The current method for treating impingement in FAI involves iterative debridement and confirmation of the restored ROM. Over resection is likely to occur because the resection outcome can only be assessed after the debridement [2]. To solve this problem, a noninvasive technique to assess hip ROM for FAI has been developed. The aim of this study is to reliably predict the resulting functional ROM achieved for a given pre-operative resection plan in FAI.

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